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AIR-CONDITIONING APPARATUS FOR VEHICLE

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AIR-CONDITIONING APPARATUS FOR VEHICLES

[Sharyo yo kukichowasochi]

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[There are no amendments to this patent.]

<u>Claim</u>

1. An air-conditioning apparatus for vehicles characterized by having the following:

a) a freezing cycle having a coolant evaporator, which performs heat exchange between a coolant at low temperature and low pressure and air, and a coolant compressor, which receives the rotation force of a driving source to compress and discharge the coolant evaporated by the aforementioned coolant evaporator;

b) a physical quantity detecting means that detects the temperature of the air blown out from the aforementioned coolant evaporator or the physical quantity corresponding to the temperature of the blown-out air;

c) an external air temperature detecting means that detects the temperature of the external air;

d) an electromagnetic clutch that is installed between the aforementioned driving source and the coolant compressor to intermittently transfer the rotation force of the aforementioned driving source to the aforementioned coolant compressor based on an on/off signal;

e) a hysteresis setting means that sets the hysteresis of the aforementioned on/off signal in such a way that the hysteresis is reduced by as much as the drop in the temperature of the external air detected by the aforementioned external air temperature detecting means; and

f) an on/off signal output means that outputs the aforementioned on/off signal with the hysteresis set by the aforementioned hysteresis setting means corresponding to the temperature of the aforementioned blown-out air or the physical quantity equivalent to the temperature of the blown-out air detected by the aforementioned physical quantity detecting means.

Detailed explanation of the invention

[0001]

Industrial application field

The present invention pertains to an air-conditioning apparatus for vehicles.

[0002]

Prior art

When the inner surface of the window glass of a vehicle becomes foggy, the fog on the window glass can usually be removed by introducing external air at a lower temperature into the vehicle. When the temperature and humidity of the external air are relatively high in the rainy season, the fog on the window glass can be removed by dehumidifying the interior of the vehicle by turning on the air conditioner (turning on the coolant compressor).

[0003]

Problems to be solved by the invention

However, in cold areas where there are a lot of vehicles equipped with spike tires in the winter, since road material is scraped off by the spike tires to generate a large amount of dust flying in the air, sometimes, the driver is forced to switch to internal air circulating mode to prevent the dust from entering the vehicle. When the window glass becomes foggy during internal air circulation, the driver usually turns on the air conditioner. However, the coolant compressor is subjected to on/off control, and the off time of the coolant compressor is prolonged when the temperature of the external air is low. Consequently, even if the fog on the window glass can be removed when the coolant compressor is on, the window glass will become foggy again when the coolant compressor is off. The purpose of the present invention is to

provide an air-conditioning apparatus for vehicles which can effectively prevent fogging on the inner side of window glass in internal air circulating mode.

[0004]

Means to solve the problems

In order to realize the aforementioned purpose, the present invention adopts a technical means having the following: a freezing cycle having a coolant evaporator, which performs heat exchange between a coolant at low temperature and low pressure and air, and a coolant compressor, which receives the rotation force of a driving source to compress and discharge the coolant evaporated by the aforementioned coolant evaporator; a physical quantity detecting means that detects the temperature of the air blown out from the aforementioned coolant evaporator or the physical quantity corresponding to the temperature of the blown-out air; an external air temperature detecting means that detects the temperature of the external air; an electromagnetic clutch that is installed between the aforementioned driving source and the coolant compressor to intermittently transfer the rotation force of the aforementioned driving source to the aforementioned coolant compressor based on an on/off signal; a hysteresis setting means that sets the hysteresis of the aforementioned on/off signal in such a way that the hysteresis is reduced by as much as the drop in the temperature of the external air detected by the aforementioned external air temperature detecting means; and an on/off signal output means that outputs the aforementioned on/off signal with the hysteresis set by the aforementioned hysteresis setting means corresponding to the temperature of the aforementioned blown-out air or the physical quantity equivalent to the temperature of the blown-out air detected by the aforementioned physical quantity detecting means.

[0005]

Operation and effects of the invention

In the air-conditioning apparatus for vehicles of the present invention with the aforementioned configuration, the electromagnetic clutch is subjected to on/off control conducted based on the on/off signal output from the on/off signal output means. The hysteresis of the on/off signal is set by the hysteresis setting means in such a way that that the hysteresis is reduced by as much as the drop in the temperature of the external air. Consequently, since the on/off period of the coolant compressor is shortened corresponding to the drop in the temperature of the external air, the off time of each round is also shortened. As a result, the off time of the coolant compressor is shorter compared with that when the temperature of the external air is high. In this way, the fog formed on the window glass during the off time of the coolant compressor during internal air circulation can be prevented.

[0006]

Application example

In the following, an application example of the air-conditioning apparatus for vehicles will be explained based on Figures 1-4. Figure 1 is a schematic diagram illustrating the entire air-conditioning apparatus for vehicles. The air-conditioning apparatus 1 for vehicles disclosed in this application example has duct 2 that guides the air into the vehicle, air blower 3 that is installed on the upstream side of duct 2 to blow air into the vehicle via duct 2, a freezing cycle 4 that constitutes the cooling means, heat core 5 that constitutes the heating means, and air-conditioner control device 6. Air blower 3 is comprised of blower case 3a, centrifugal fan 3b, and blower motor 3c. The rotation speed of blower motor 3 is determined corresponding to the voltage applied to said blower motor 3c. The blower voltage is controlled based on the control signal sent from air-conditioner control device 6 via a motor driving circuit 7 (see Figure 2). Internal air inlet 8 used for feeding the air in the vehicle (internal air) and external air inlet 9 used for feeding the air outside the vehicle (external air) are formed in blower case 3a. There is an internal/external switching damper 10 that selectively opens/closes internal air inlet 8 and external air inlet 9 corresponding to the inlet mode.

[0007]

The downstream end of duct 2 is branched into defroster duct 2a, face duct 2b, foot duct 2c. The ends of said ducts 2a-2c are used as defroster outlet 11, face outlet 12, and foot outlet 13 that are open to the interior of the vehicle. An outlet switching damper 14, which selectively opens/closes defroster duct 2a and face duct 2b corresponding to the outlet mode, is installed in the upstream opening parts of defroster duct 2a and face duct 2b. An outlet switching damper 15, which opens/closes foot duct 2c corresponding to the outlet mode, is installed in the upstream opening part of foot duct 2c. Defroster outlet 11 is opened in such a way that the blown-out air is blown toward window glass 16 of the vehicle. Face outlet 12 is opened in such a way that the blown-out air is blown toward the head and shoulder of the driver. Foot outlet 13 is opened in such a way that the blown out air is blown toward the feet of the driver.

[0008]

Freezing cycle 4 is comprised of coolant compressor 18 driven by the engine (driving source used in the present invention: not shown in the figure) via electromagnetic clutch 17, coolant condenser 20 that receives the air sent from cooling fan 19 to condense and liquefy the coolant with high temperature and high pressure compressed by said coolant compressor 18, receiver 21 that temporarily stores the coolant sent from coolant condenser 20 and only makes

the liquid coolant flow, depressurizing device 22 that depressurizes the liquid coolant sent from receiver 21, and coolant evaporator 23 that is installed in duct 2 and receives the air sent from air blower 3 to evaporate the coolant with low temperature and low pressure depressurized by depressurizing device 22. These functional parts are connected in a ring shape by coolant pipes 24. Electromagnetic clutch 17 is subjected to on/off control conducted based on the control signal (on/off signal) output from air-conditioner control device 6 via clutch driving circuit 25. Heater core 5 is installed on the downstream side (downwind side) of coolant evaporator 23 in duct. The air is heated through heater core 5 with the engine cooling water used as the heat source. Said heater core 5 is arranged inside duct 2 in an appropriate manner to form such a bypass 26 that the air flowing inside duct 2 makes a detour around heater core 5. The proportion of the amount of the air flowing through bypass 26 and the proportion of the amount of the air flowing through heater core 5 are adjusted by an air mixing damper 27 arranged in duct 2.

[0009]

Air-conditioner control device 6 has an incorporated microcomputer 6a. The operating signal output from air-conditioner operating panel 28 and the detection signal output from each sensor (to be described later) are input into the microcomputer, which processes these signals and outputs control signals to servo motors 29, 30, 31 that drive various dampers (internal/external air switching dampers 10, outlet switching dampers 14, 15, air mixing damper 27), to motor driving circuit 7 that drives the blower motor of air blower 3, and to clutch driving circuit 25 that drives electromagnetic clutch 17 (see Figure 2). The aforementioned sensors include internal air sensor 32 that can detect the internal air temperature Tr, external air sensor 33 that can detect the external air temperature Tam, sunlight sensor 34 that can detect the sunlight quantity Ts, post-evaporation temperature sensor 35 that can detect the temperature Te of the air blown out from coolant evaporator 23, and water temperature sensor 36 that can detect the temperature Tw of the engine cooling water supplied to heater core 5, etc. Air-conditioner operating panel 28 is arranged on the installment panel (not shown in the figure) inside the vehicle. Temperature setter 28a that can set the desired indoor temperature for the driver, air-conditioner switch 28b that can send an instruction for driving coolant compressor 18 to air-conditioner control device 6, outlet mode switch 28c that can select the outlet, inlet mode switch 28d that can select the inlet (internal air inlet 8 and external air inlet 9), and fan switch 28e that can adjust the air amount of air blower 3, etc. are arranged on the air-conditioner operating panel.

[0010]

The on/off signal output from air-conditioner control device 6 to latch driving circuit 25 is determined based on the relationship between the on/off temperature of coolant compressor 18 prestored in microcomputer 6a and the external air temperature Tam. In the following, the relationship between external air temperature Tam and the on/off temperature of coolant compressor 18 will be explained. In this application example, as shown in Figure 4, the set value of the on/off temperature of coolant compressor 18 decreases continuous (linearly) along with the drop in external air temperature Tam when the external air temperature Tam is in the range of 0-5°C. When the external air temperature Tam is higher than 5°C, the interval (hysteresis) of the on/off temperature of coolant compressor 18 is set to 1°C. When the external air temperature Tam is below 0°C, the interval of the on/off temperature of coolant compressor 18 is set to 0.5°C. The interval of the on/off temperature of coolant compressor 18 is set to decrease continuously along with the drop in the external air temperature Tam (when the external air temperature Tam is in the range of 0-5°C).

[0011]

In the following, the operation of this application example pertaining to the on/off control of coolant compressor 18 will be explained based on the processing sequence of air-conditioner control device 6. Figure 3 is a flow chart illustrating the processing sequence of air-conditioner control device 6. First, the detection signals sent from external air sensor 33 and post-evaporation temperature sensor 35 (external air temperature Tam, and blown-out air temperature Te) are read (step S1). Then, it is determined whether air-conditioner switch 28b has been turned on (step S2). If it is found in step S2 that air-conditioner switch 28b is not turned on (NO), since there is no need to drive coolant compressor 18, an off signal used for turning off electromagnetic clutch 17 is output to clutch driving circuit 25 (step S3: on/off signal output means). After that, the process goes back to step S1. If it is found in step S2 that air-conditioner switch 28b is turned on (YES), the on/off temperature of coolant compressor 18 is determined corresponding to the external air temperature Tam from the diagram shown in Figure 4 (step S4: hysteresis setting means). Then, it is determined whether air-conditioner 18 should be turned on/off corresponding to the temperature Te of the air blown out from coolant evaporator 23 detected by post-evaporation temperature sensor 35 with respect to the on/off temperature of coolant compressor 18 determined in step S4. If it is determined in step S5 that coolant compressor 18 should be turned off, an off signal for turning off electromagnetic clutch 17 is output to clutch driving circuit 25 (step S3: on/off signal output means). Then, the process goes back to step S1. If it is determined in step S5 that coolant compressor 18 should be turned on, an on signal for turning on

electromagnetic clutch 17 is output to clutch driving circuit 25 (step S6: on/off signal output means). Then, the process goes back to step S1.

[0012]

As described above, in this application example, the on/off temperature of coolant compressor 18 varies corresponding to the external air temperature Tam. When the external air temperature Tam drops below 5°C, the interval of the on/off temperature of coolant compressor 18 is reduced along with the drop in the external air temperature Tam. When the external air temperature Tam is below 0°C, the interval of the on/off temperature of coolant compressor 18 is set to 0.5°C. Consequently, when the external air temperature Tam is below 0°C, the on/off period of electromagnetic clutch 17 becomes shorter than that when the external air temperature Tam is above 0°C (especially, when it is above 5°C). The off time of each round also becomes shorter. As a result, since the stop time of coolant compressor 18 becomes shorter than that when the external air temperature Tam is high, even if the driver must switch to internal air mode (internal air circulation) due to polluted external air, fog can be prevented from forming on window glass 16 when coolant compressor 18 is stopped. Also, in this application example, since the set value of the on/off temperature of coolant compressor 18 decreases along with the drop in the external air temperature Tam, the temperature Te of the air blown out from coolant evaporator 23 also drops. As a result, it is difficult for fog to form on window glass 16. When the interval of the on/off temperature of coolant compressor 18 is reduced, the number of times that electromagnetic clutch 17 is interrupted is increased. In this case, however, since the high pressure inside freezing cycle 4 is lower than that when the external air temperature Tam is high, the driving torque of coolant compressor 18 is also reduced. Consequently, the shock occurring in company with the on/off operation of coolant compressor 18 is also reduced. Even if the number of times that electromagnetic clutch 17 is interrupted is increased, the reliability of freezing cycle 4 will not be deteriorated.

[0013]

Modification example

In this application example, the interval (hysteresis) of the on/off temperature of coolant compressor 18 is set to decrease along with the drop in the external air temperature Tam as shown in Figure 4. This is not the only choice. For example, as shown in Figure 5, it is also possible to change the interval of the on/off temperature of coolant compressor 18 by only changing the on temperature of coolant compressor 18 corresponding to the external air temperature Tam. In this application example, when the external air temperature Tam is in the range of 0-5°C, the interval of the on/off temperature of coolant compressor 18 is set to decrease

continuously (linearly) along with the drop in the external air temperature Tam. The interval, however, can also be changed stepwise. In this way, the apparatus may have a configuration less expensive than that when the interval is changed linearly. In this application example, the on/off operation of coolant compressor 18 is controlled based on the temperature Te of the air blown out from coolant evaporator 23. However, it is also possible to control the on/off operation of coolant compressor 18 based on a physical quantity equivalent to the temperature of the blown-out air (such as, the fin temperature of coolant evaporator 23, the evaporating temperature of coolant evaporator 23, the coolant temperature or coolant pressure of coolant evaporator 23) besides the temperature of the air blown out from coolant evaporator 23.

Brief description of the figures

Figure 1 is a schematic diagram illustrating the entire air-conditioning apparatus for vehicles disclosed in an application example.

Figure 2 is a block diagram pertaining to the air-conditioner control in this application example.

Figure 3 is a flow chart illustrating the processing sequence of the air-conditioner control device.

Figure 4 is a diagram illustrating the relationship between the on/off temperature of the coolant compressor and the temperature of the external air.

Figure 5 is a diagram illustrating the relationship between the on/off temperature of the coolant compressor and the temperature of the external air in an modification example of the application example.

Explanation of symbols

1 Air-conditioning apparatus for vehicles

4 Freezing cycle

6 Air-conditioner control device (hysteresis setting means, on/off signal output means)

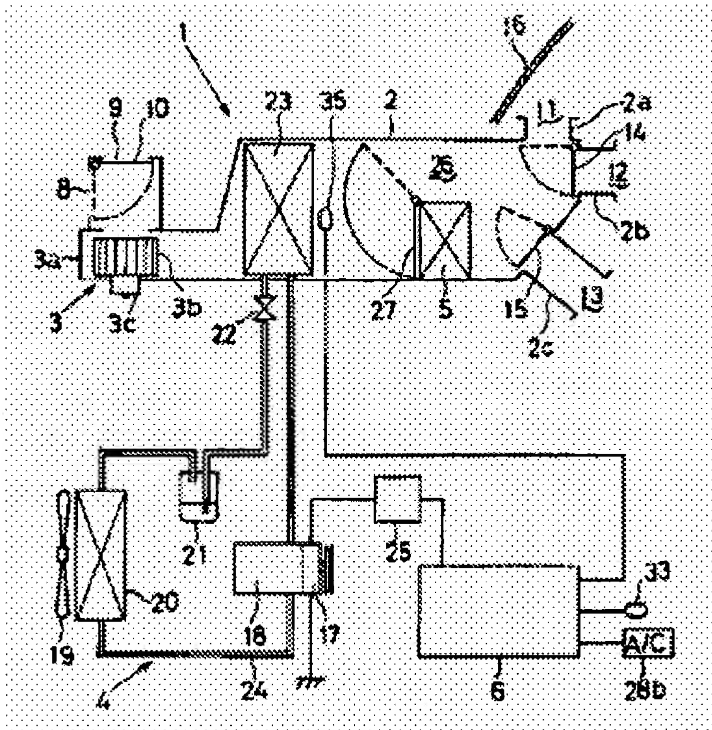
17 Electromagnetic clutch

18 Coolant compressor

23 Coolant evaporator

33 External air sensor (external air temperature detecting means)

35 Post-evaporation temperature sensor (physical quantity detecting means)


1
9
10
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2
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2a
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12
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3c
3b
22
27
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2c
21
25
33
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6
28b
4
A/C

Figure 1

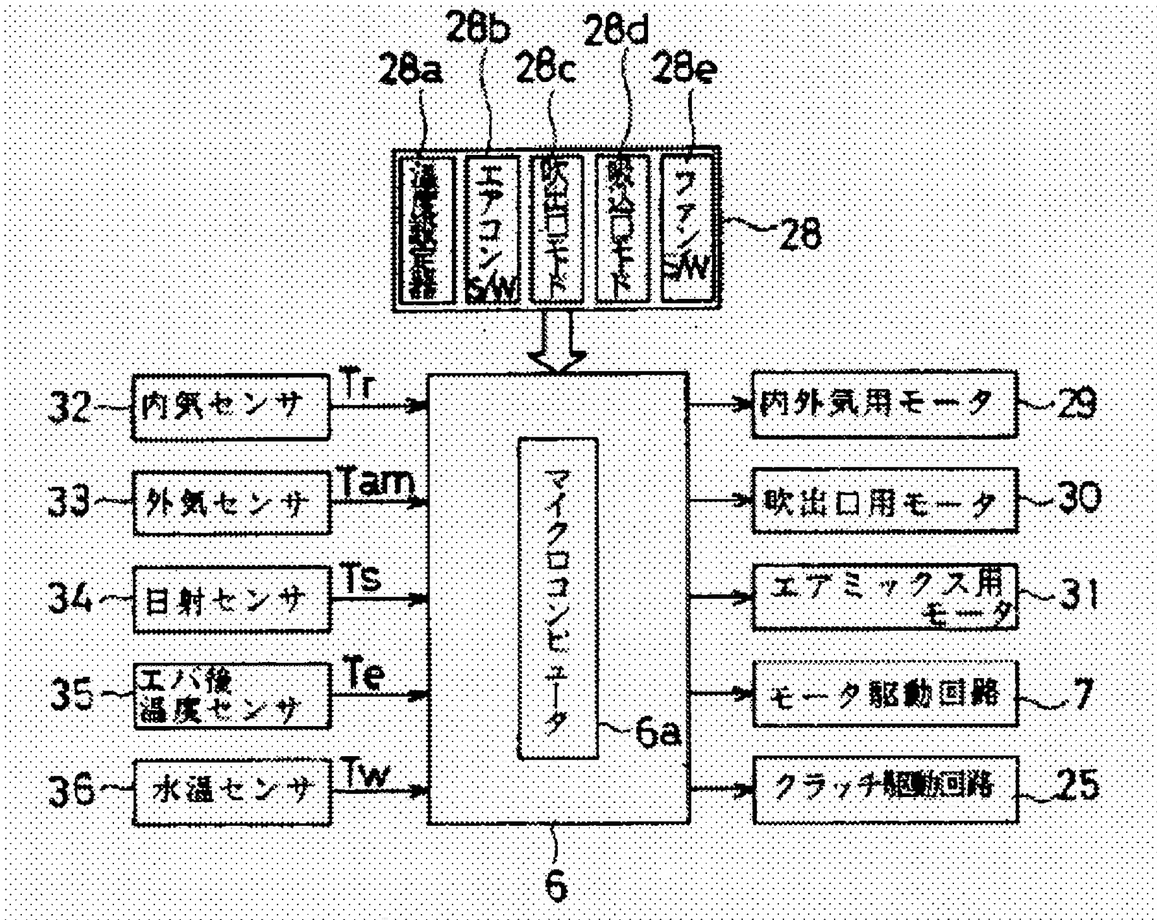

Figure 2

Key:		
	6a	Microcomputer
	7	Motor driving circuit
	25	Clutch driving circuit
	28a	Temperature setter
	28b	Air-conditioner switch
	28c	Outlet mode
	28d	Inlet mode
	28e	Fan switch
	29	Motor for internal/external air
	30	Motor for outlet
	31	Motor for air mixing
	32	Internal air sensor
	33	External air sensor
	34	Sunlight sensor
	35	Post-evaporation temperature sensor
	36	Water temperature sensor

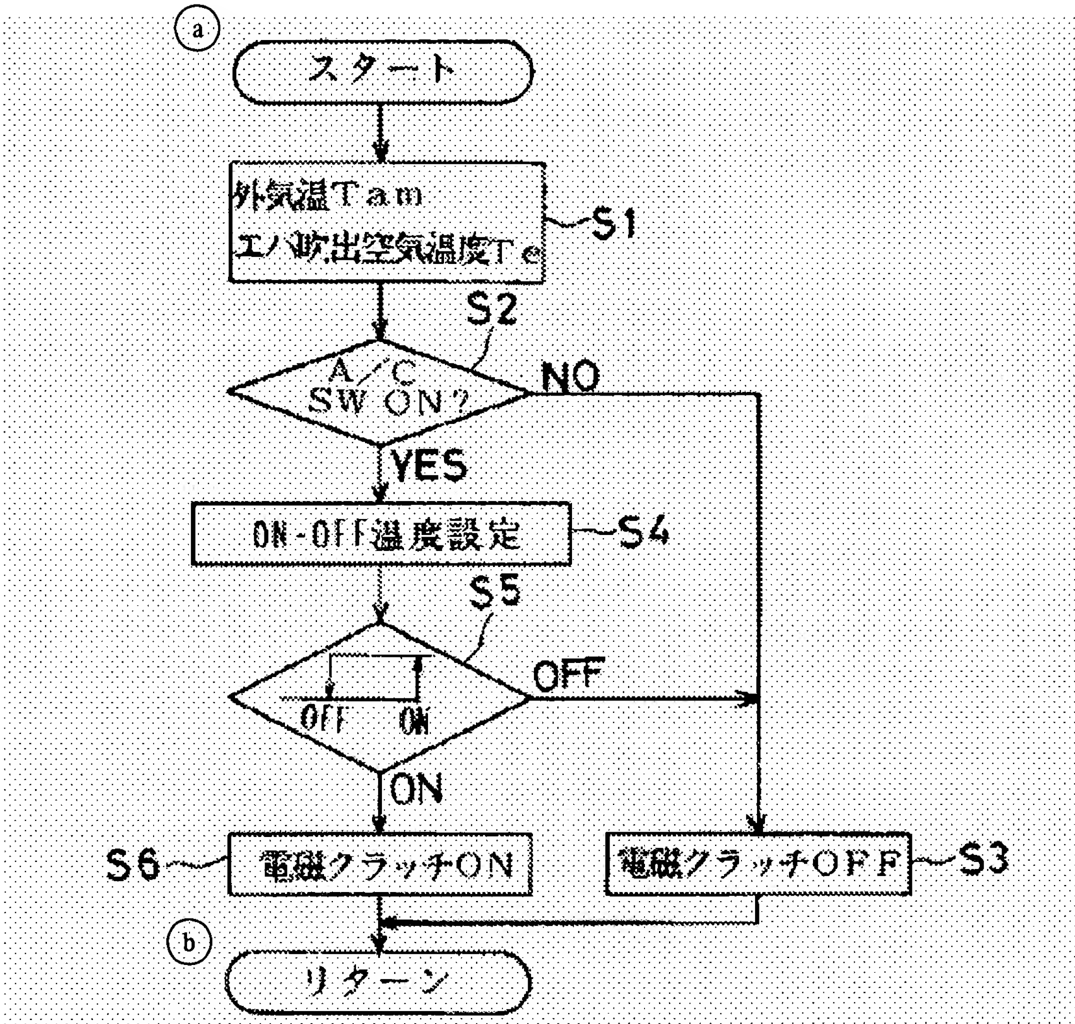

Figure 3

Key:

Key:	a	Start
	b	Return
	S1	External air temperature Tam
	S2	Temperature Te of the air blown out from the coolant evaporator
	S3	Electromagnetic clutch OFF
	S4	Set ON-OFF temperature
	S6	Electromagnetic clutch ON

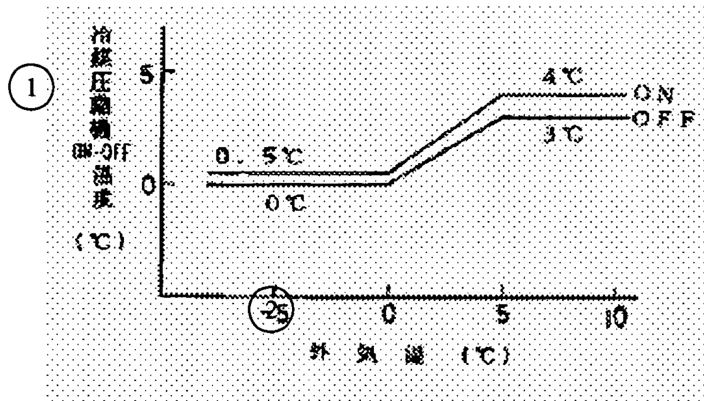

Figure 4

Key: 1 ON-OFF temperature of coolant compressor
2 Temperature of external air

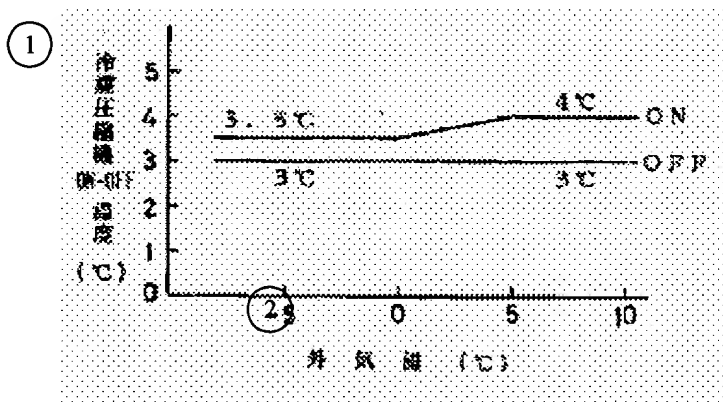

Figure 5

Key: 1 ON-OFF temperature of coolant compressor
2 Temperature of external air